Engineering waveguides in holographically-defined photonic crystals

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Waveguides and resonators that exploit the high level of optical isolation achieved within a photonic crystal have the potential to increase the packing density of integrated optical components by 10^4~10^6. We demonstrate the use of two-photon microfabrication to create optical device structures within a 3D holographically-defined photonic crystal.

Holographic lithography uses a 3D interference pattern to define the microstructure of a photonic crystal. The periodic light intensity generates a periodic distribution of H^+ ions by single-photon excitation of a photoacid generator (PAG). Using a confocal microscope we can map and modify the photoacid distribution; acid-catalyzed polymerization is then initiated by heating. An acid-sensitive dye is used to generate a 3D photoacid map; additional structure is generated by two-photon excitation of the PAG at the microscope's focus. During development, material that has received below-threshold exposure is removed to reveal the photonic crystal incorporating precisely positioned structural defects - the building blocks of photonic crystal waveguides. Waveguides buried within the depth of the developed crystal are imaged by confocal microscopy by using a second dye to infiltrate the voids in the structure.